STRATEGY RESEARCH PROJECT

GEOSPATIAL INFORMATION REQUIREMENTS OF THE OBJECTIVE FORCE

BY

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ABSTRACT

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While there has been much debate on the type of vehicle that will be needed for the Objective Force, there is little awareness concerning the need for geospatial information to support full situational awareness, dominant maneuver, precision engagement, focused logistics, and full dimensional protection. Today's digital map is only the foundation for the types of information that will be required to meet tomorrow's full range of military missions. Geospatial information contributions to battlespace awareness include: finding the enemy within their dwell time, precise target location, ability to locate areas where maneuver profile is lower, seeing the terrain in greater clarity, identification of friendly and enemy forces by spectral signature, and use of hyperspectral technology to determine hazardous environmental conditions. The Army must make near term investments to ensure geospatial information systems are incorporated in the Future Combat System so that full spectrum dominance and rapid decision superiority is obtained. This paper will address why geospatial information must be addressed now and suggest changes that should be undertaken to supply the armed forces with geospatial knowledge.

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GEOSPATIAL INFORMATION REQUIREMENTS OF THE OBJECTIVE FORCE

Geospatial information will continue to be a critical force multiplier, but it will be geospatial knowledge that will become the key enabler for military, diplomatic, and economic elements of power. The use of geospatial information has been addressed in recent Army and Joint Publications. Geospatial information is the basis of which signal intelligence (SIGINT), human intelligence (HUMINT), electronic intelligence (ELINT), communication intelligence (COMINT), and other information is integrated.

One of the most important determinants of success for 21st century militaries will be the extent to which they react faster than their opponents. Tactical and operational speed can be attributed to information technology, doctrine, and training. In addition to the speed needed to move into a theater of operations, strategic speed will entail faster decision-making.[1]

The official vision of future war reflects the belief that "information superiority" will be the lifeblood of a postmodern military and the key to battlefield success. According to former Secretary of Defense William Cohen, "The ongoing transformation of our military capabilities - the so-called Revolution in Military Affairs (RMA) - centers on developing the improved information and command and control capabilities needed to significantly enhance joint operations."[2] Without a superior geospatial information foundation, information superiority cannot exist.

A proliferation of technology has provided today's decision-makers with excessive amounts of data and information. However, having too much information is often counterproductive to rapid decision-making. Because of increased computing power, many have come to believe that front-line soldiers need the equivalent density of information as high-end modeling and simulation systems. However, little consideration has been given to the comprehension of excessive amounts of data and information.

In 2020, geospatial information will remain a critical element of information superiority. However, we cannot continue to base our future requirements on today's methods of supplying highly detailed information. For the Objective Force to swiftly comprehend the battlespace and respond quickly and accurately, it will require geospatial information and knowledge that is quickly absorbed and understood.

With the speed of future operations, soldiers should not be expected to exploit information directly. Even with exponential growth in computing power, soldiers have too much to handle without performing geospatial analysis. Therefore, the geospatial community must provide nuggets of knowledge to soldiers instead of information.

JOINT VISION 2020

> In 2020, the nation will face a wide range of interests, opportunities, and challenges and will require a military that can both win wars and contribute to peace. The global interests and responsibilities of the United States will endure, and there is no indication that threats to those interests and responsibilities, or to our allies, will disappear.
>
> —Joint Vision 2020

Joint Vision 2020 (JV2020) builds upon the Joint Vision 2010 conceptual template which described the operational concepts of Dominant Maneuver, Precision Engagement, Full-Dimensional Protection, and Focused Logistics. As illustrated in Figure 1, Joint Vision 2020 adds Information Superiority as an essential capability that supports the other four concepts.[3]

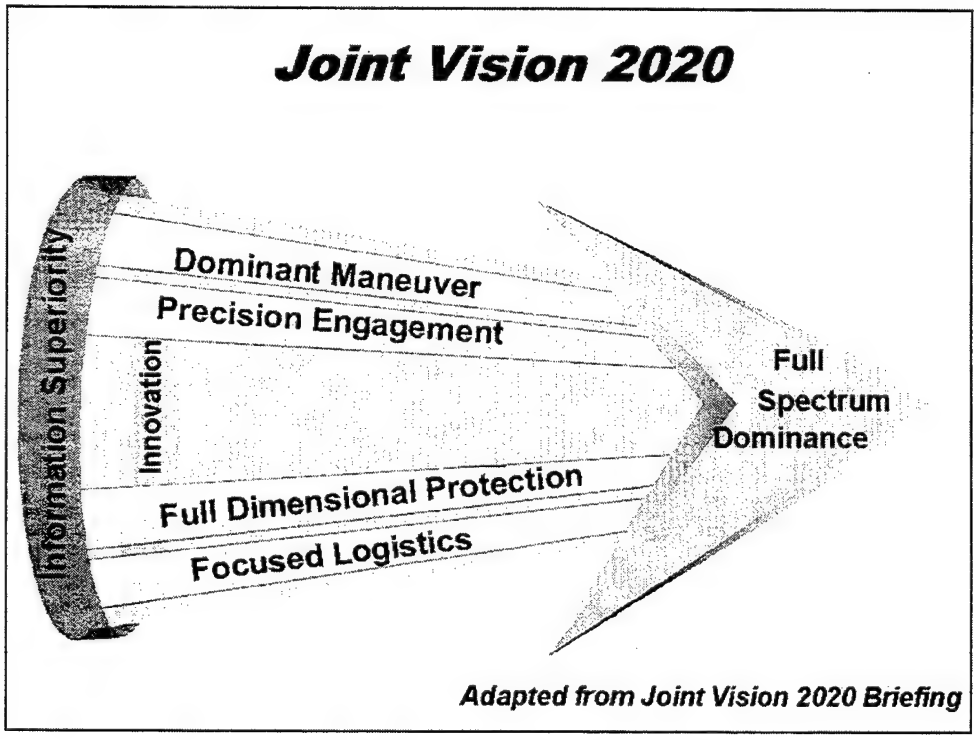

FIGURE 1. JOINT VISION 2020

Information Superiority. Information superiority is the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same.[4] Because of Information Superiority, commanders will be able to formulate and disseminate intent based upon up-to-date knowledge of the battlespace.

Dominant Maneuver. The ability to attain positional advantage with decisive speed and overpowering tempo is called Dominant Maneuver. The employment of widely dispersed joint air, land, sea, amphibious, special operations and space forces is achieved through Information

Superiority which enables adaptive and concurrent planning; coordination of widely dispersed units; gathering of timely feedback on the status, location, and activities of subordinate units; and anticipation of the course of events leading to mission accomplishment.

Precision Engagement. Precision Engagement is the ability to locate, identify, observe, and track objectives; use the correct engagement systems; generate desired outcomes; assess results; and reengage with decisive speed and overwhelming tempo. Information superiority enhances this concept by enabling commanders to understand the situation, determine the effects desired, and select the appropriate course of action.

Focused Logistics. Focused Logistics is the capability to provide the right personnel, equipment, and supplies at the right time, at the right place, in the right quantity. Information superiority enables a real-time, web-based information system that supports total asset visibility as part of a common relevant operational picture, effectively linking the operator and logistician across Services and support agencies.

Full Dimensional Protection. Protection of personnel and assets required to decisively execute tasks is called Full-Dimensional Protection. Information Superiority contributes to protection through the selection and application of multi-layered active and passive measures, within the domains of air, land, sea, space, and information.

Decision Superiority. Decision Superiority results from enhanced information filtered through the commander's experience, knowledge, training, and judgment; the expertise of supporting staffs and other organizations; and the efficiency of associated processes.[5] JV2020 notes that decision superiority does not automatically result from information superiority. The "human in the loop" with a complete understanding of command and control and organization collaboration enables information to be translated into options and decisions quicker.

CONTRIBUTION OF GEOSPATIAL INFORMATION TO JV2020 OPERATIONAL CONCEPTS

Geospatial information is referenced to locations on the surface of the earth and, as such, becomes the foundation upon which other battlespace information is integrated. Without the basic building blocks of geospatial information, information superiority cannot succeed. Geospatial information provides the basic framework for battlespace visualization, planning, decisions, and actions. As illustrated in Table 1, geospatial information fully supports JV2020 concepts.

Operational Concept	Elements	Geospatial Contributions
Dominant Maneuver	Decisive Speed	Know where to go and the fastest way to get there
	Positioning and Repositioning	Know locations of combat element
	Massed Effects	Know locations of opponent's forces and civilian enclaves
Precision Engagement	Right Target	Know enemy and friendly locations
	Right Weapon	Know the terrain and environmental effects enables correct weapon choice
	Desired Effect	Know building materials enables knowledge about effects
Focused Logistics	Right Place	Know precise locations
	Right Time	Know length of time required to arrive at location
Full-Dimensional Protection	Theater Assets	Know locations of all assets
	Protection	Know weather effects on personnel and equipment

TABLE 1. GEOSPATIAL CONTRIBUTIONS TO JV2020 OPERATIONAL CONCEPTS

GEOSTRATEGIC THREATS AND- IMPLICATIONS FOR GEOSPATIAL INFORMATION

> In the years ahead, borders of every sort - geographical, communal, and psychological - will be stressed, strained, and compelled to reconfigurations.
> —U.S. Commission on National Security/21st Century

The geostrategic environment has become increasingly complex. Today, Army forces are more likely to encounter conditions of greater ambiguity and uncertainty than has even been experienced in the past. It is expected that major wars between nations will decrease, while small-scale conflicts will likely increase.

Global communications accelerate and expand American awareness of events, issues, and concerns that challenge U.S. security and national interests. Joint Vision 2020 acknowledges this acceleration of awareness and states that the 21st Century security environment will require U.S. involvement in peacekeeping, helping stabilizing failed states, thwarting transnational and non-state actors, combating terrorism, monitoring weapons proliferation and weapons of mass destruction, and guaranteeing the security of U.S. information.[6] As illustrated in Figure 2, the U.S. Military will be called upon to support the entire spectrum of military operations.

Most U.S. interventions will be accomplished with fewer forward deployed troops and require rapid deployment from the U.S. This will require the military to operate in previously unknown geographic regions, requiring a full and rapid understanding of the terrain in order to achieve success.

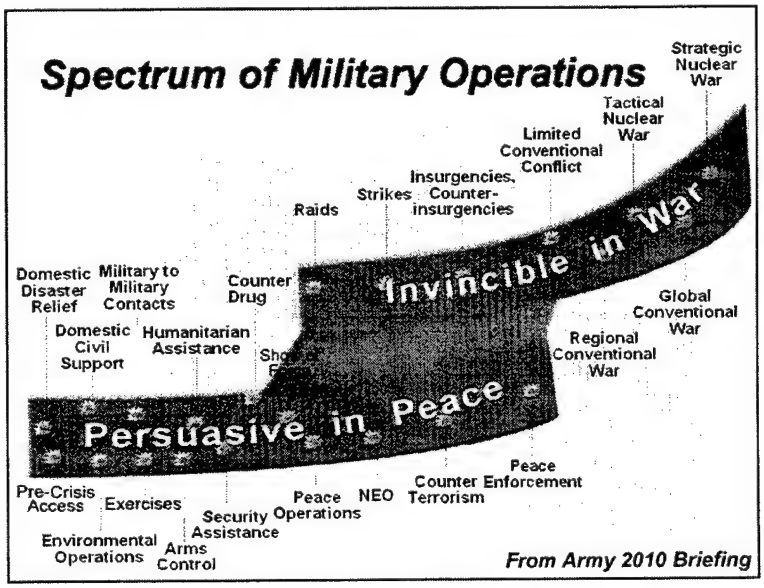

FIGURE 2. SPECTRUM OF MILITARY OPERATIONS

ARMY TRANSFORMATION

> We can transform today in a time of peace and prosperity. Or we can try to change tomorrow on the eve of the next war, when the window has closed, our perspective has narrowed, and our potential limited by the press of time and the constraints of resources.
>
> —General Eric. K. Shinseki, 2000-2001 AUSA Greenbook

The future security environment demands that the United States be prepared to face a wide range of threats which will require operations based on force projection, rather than forward presence. To meet these requirements, the Army has begun the process of transformation, which will enable the Army to respond to all geostrategic threats ranging from disaster relief to full-scale war. The Army's goal is to have a force that is more responsive, deployable, agile, versatile, lethal, survivable, and sustainable than the current force.[7]

As illustrated in Figure 3, transformation will be accomplished through three simultaneous configurations: Legacy Force, Interim Force, and the Objective Force. This mix of pathways ensures continued dominance.[8]

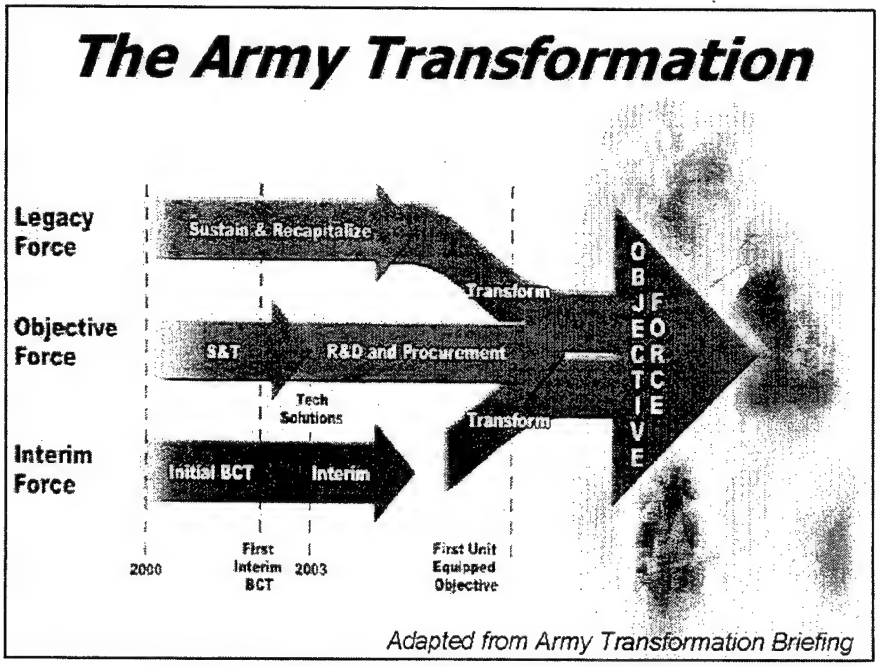

FIGURE 3. ARMY TRANSFORMATION

Legacy Force. The Legacy Force guarantees near-term readiness by maintaining existing capabilities. Selected units and systems will be recapitalized to increase service life, reduce maintenance costs, and improve logistical support requirements. Digital technologies and

enhancements from Division XXI will be inserted to improve direct fires and provide greater situational awareness.[9]

Interim Force. The Interim Force will fill the capability gap until the Objective Force can be fully implemented. It is a combined arms, full spectrum force that is highly mobile at the strategic, operational, and tactical levels. The Interim Brigade Combat Team (IBCT) will rapidly deploy, execute early entry, and conduct effective combat operations immediately on arrival. The IBCT will include a reconnaissance, intelligence, surveillance, and target acquisition squadron that will increase survivability through situational awareness. Since the IBCT will be used to validate the operational and organizational design, it will provide valuable transformation insights.

Objective Force. The Objective Force encompasses a complete transformation of the Army. It also includes a new organization, new training techniques, and a new way of conducting warfare. The Objective Force will be capable of rapidly responding to crises, shaping the operational environment, and succeeding across the full spectrum of operations. It will possess the capabilities to fight a major war while maintaining the flexibility to conduct a wide range of small-scale contingency. The Objective Force will operate in a distributed, non-linear battlespace. It will be linked internally and externally through a responsive, internetted C4ISR capability. Joint and interagency reachback capabilities for intelligence, planning, administration and logistical support will be available. It will be at least 2010 before enough of the Objective Force will be available as a fighting unit. By 2032, the entire Army will be transformed into the Objective Force.[10]

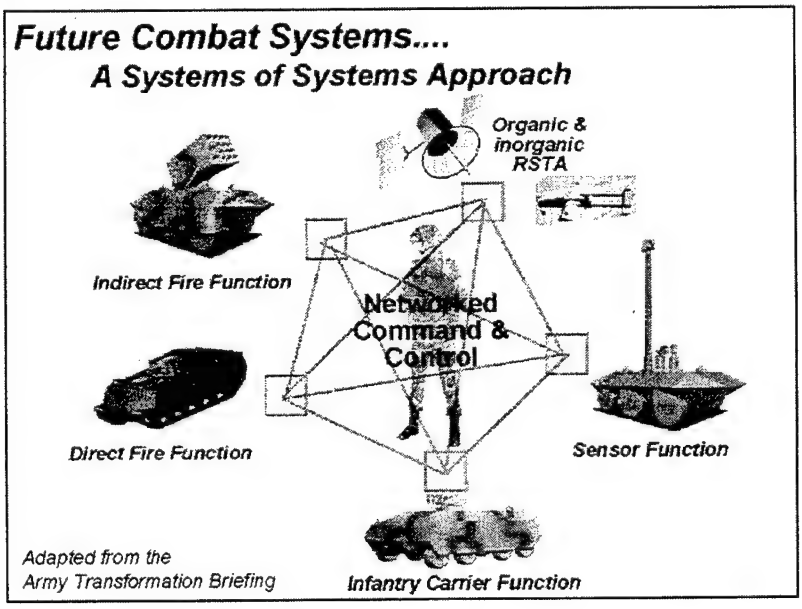

FIGURE 4. FUTURE COMBAT SYSTEM

One of the key elements of the Objective Force is the Future Combat System (FCS), a multi-mission combat system capable of supporting the full spectrum of missions. As a "system of systems" (Figure 4), the FCS will rely on a network-centric approach to meeting the Army's requirements.[11]

The Objective Force will have combat capable, "boots on the ground" capabilities within 96 hours. This rapid deployment schedule will not provide enough time for the force to conduct extensive mission rehearsal. Therefore, its survival and success will require superior situational awareness and accurate, relevant geospatial knowledge.

GEOSPATIAL INFORMATION

FOUNDATION OF GEOSPATIAL INFORMATION

Since geospatial information incorporates the domains of land, sea, air, and space, it provides the fundamental framework of battlespace information. As such, it is the basic component of the Information Superiority tenet of Joint Vision 2020.

Geospatial information encompasses geodetic, geomagnetic, imagery, gravimetric, aeronautical, topographic, hydrographic, littoral, cultural, and toponymic data that are accurately referenced to a precise location on the surface of the earth. At its basic level, geospatial information provides a "map" which can be used to indicate location.

Multiple sources are used to produce geospatial information, which may be presented in the form of printed maps, charts, and publications; in digital simulation and modeling data bases; in photographic form; or in the form of digitized maps and charts or attributed centerline data.[12]

Geospatial information is widely used by the commercial, national, and defense communities. Geographic factors (see Table 2) of physical and cultural geography influence military operations, national security, and commercial activities.[13]

Today's commercial market for geospatial products is large and rapidly growing. Some uses of commercial geospatial products include agriculture, land management, infrastructure management, and the news media.

Non-defense, government use of geospatial information includes water monitoring, disaster management, boundary determination, and environmental management.

Physical Factors	Cultural Factors
Spatial Relationships and Patterns	Racial and Ethnic Roots
Topography and Relief	Population Patterns
Geology and Soils	Social Structures
Vegetation	Languages and Religions
Oceans and Seashores	Industries and Land Use
Weather and Climate	Transportation Networks
Daylight and Darkness	Telecommunications
Gravity and Magnetism	Military Installations
Surface and Ground Water	Economies
Natural Resources	Demographics
	Health and Diseases

TABLE 2. GEOGRAPHIC FACTORS

The fundamental parameters of geospatial information in the national, commercial, and defense communities are geography and time. As such, they provide a natural reference framework for information superiority. The defense community then uses the geospatial framework to integrate other information.

RELEVANCE OF GEOSPATIAL INFORMATION TO MILITARY OPERATIONS

The geospatial elements of geography and time provide military leaders with the canvas upon which to apply the art of command. In the past, commanders would "walk" the terrain before battle in order to understand the geographic elements and environmental factors that might affect their plans and operations. Today, geospatial technologies can help the commander "walk" the terrain without placing a foot on the ground. This intuitive understanding of geography is indispensable to strategists, planners, logisticians, and commanders.

Military Geography, a combination of physical and cultural geography, focuses on the influence of physical and cultural environments over political-military policies, plans, programs, and combat/support operations of all types in global, regional, and local contexts.[14]

Information technologies have expanded the Department of Defense use of geospatial information. Technology makes geospatial information accessible to everyone from squad leaders to Commanders in Chief. Geospatial technologies allow all elements of command to see and think as one, through a common operational picture of the battlespace.

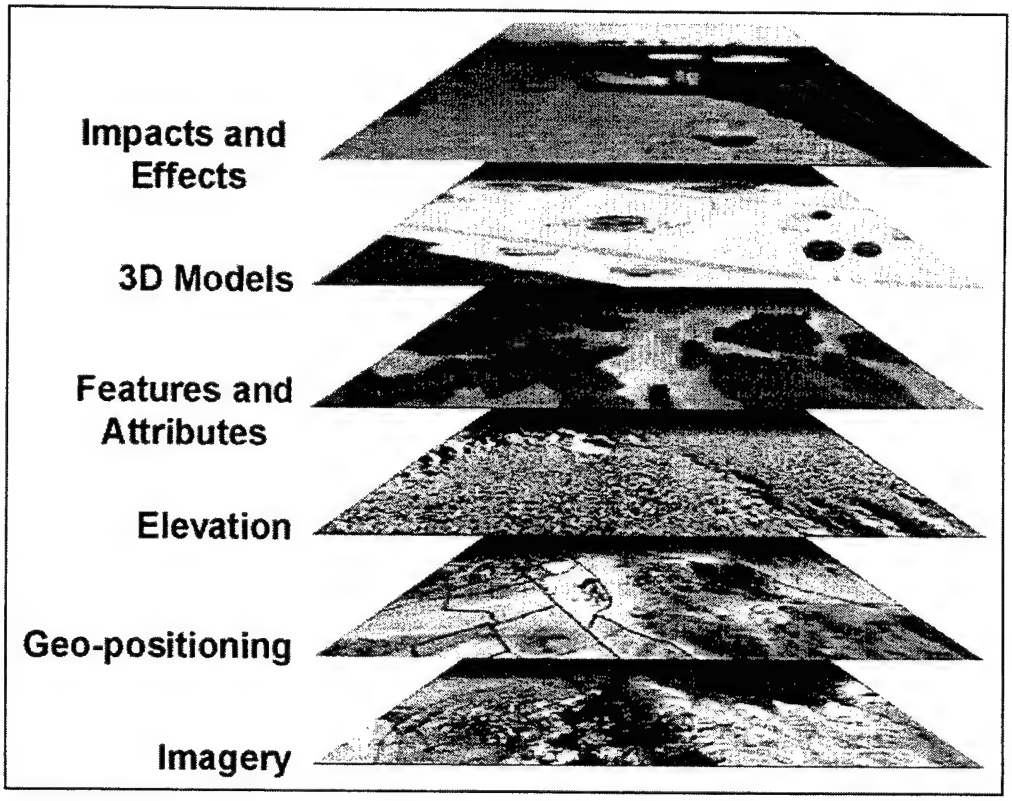

FIGURE 5. REPRESENTATIVE GEOSPATIAL INFORMATION LAYERS

As illustrated in Figure 5, the common operating picture begins with a three-dimensional topographic grid or a map upon which other information, such as imagery, survey data, man-made features, geology, weather, environmental effects, demographics, and political boundaries can be integrated. In fact, any type of information that can be correlated to a location can be integrated into the geospatial framework. Diverse sources of information such as signal emanation, friendly/enemy order of battle, logistics status, and landscape changes are easily fused into geospatial information.

In addition to the common operating picture, some of today's military geospatial information uses include intelligence preparation of the battlefield, battlespace visualization, and situation awareness.

Intelligence Preparation of the Battlefield supports military leaders with a deliberate and systematic information process based on geospatial and intelligence information that, when synthesized, creates an understanding of the battlespace.

Battlespace Visualization is the process whereby the commander develops a clear understanding of the friendly and enemy and environment, visualizes the sequence of activity, and envisions the desired end state.[15]

Situation Awareness provides a collective and shared understanding, down to the individual soldier, of the commander's assessment of the situation, the commander's intent, and the commander's concept of operations, combined with a clear picture of friendly and enemy force locations and capabilities.[16] Situational awareness provides an immediate context and relevance for the interpretation and use of new information as it is received by a soldier in a particular situation. The local situation relevant to each level and individual is developed within the common framework and shared vertically and laterally as appropriate.[17]

INFORMATION DOMINANCE

> Information superiority is the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same.
>
> —Joint Publication 1-02

> Information dominance is the degree of information superiority that allows the possessor to use information systems and capabilities to achieve an operational advantage in a conflict or to control the situation in operations short of war, while denying those capabilities to the adversary.
>
> —FM 100-6

The United States has been at the forefront of exploiting information technology and harnessing the power of rapid dissemination. Currently, U.S. geospatial information superiority has been focused on the exploitation of satellite imagery.

The exclusivity of high resolution imagery is eroding because timely and detailed views of almost any point on earth are commercially for sale. In order for the U.S. to maintain information dominance, it must make superior, faster, and more accurate use of geospatial information.[18] Information dominance can be maintained by fusing superior geospatial information with other forms of information, intelligence, surveillance, and reconnaissance and providing relevant information faster than the enemy has time to respond.[19]

As stated in Joint Vision 2020, the development of a global information grid will provide the network-centric environment required to achieve and maintain information dominance. The grid will be the globally interconnected, with end-to-end information capabilities, associated processes, and people to manage and provide information on demand. This grid will enhance combat power and contribute to the success of non-combat military operations. Technological

improvements, evolution of organizations and doctrine, and development of training will be required to maintain information dominance.[20]

REQUIREMENTS

As stated in Joint Vision 2020, Information Superiority provides critical support to the operational tenets of Dominant Maneuver, Precision Engagement, Full-Dimensional Protection, and Focused Logistics. Geospatial information provides the foundation for information dominance.

The Army has used topographic maps for over eighty years. A single, tactical topographic map (1:50,000 scale) requires more than 1,330 production hours at a cost over 32,000 dollars.[21]

The combination of 1:50,000 and 1:100,000 scale topographic maps covers less than twenty-five percent of the earth.[22] Seventy-eight percent of the available 1:50,000 scale topographic maps do not use the standard 1984 World Geodetic Survey (WGS 84) datum. Maps not using the WGS 84 datum can have positional displacements of 200 to 250 meters.[23] Positional displacements affect the common view of the battlespace, military coordination, and precision targeting.

The National Imagery and Mapping Agency (NIMA) developed numerous standard digital products to provide geospatial information for the Army and other Service systems. These products used different formats, standards, and datums, and therefore offered little contribution to a common view of the battlespace. Geospatial products require long production periods and therefore do not support today's uncertain security environment that requires U.S. forces to rapidly deploy anywhere in the world.

Recognizing the limited availability and great need for accurate geospatial information, the 1995 Defense and Army Science Boards undertook separate studies to examine the continuing shortfall. Significant Defense Science Board recommendations included:[24]

- Evolve a distributed, internet-like architecture that uses the geospatial databases as its foundation and change the defense mapping mission to "maintain the geospatial databases and protect access and integrity."
- Develop a geospatial information framework of sufficient data content and accuracy to support global preparedness, theater readiness and mission responsiveness.

The Army Science Board recommendations included:[25]

- Build global medium resolution terrain database
- Establish rapid response production capability

- Establish program to exploit emerging production technologies

As a result of these studies, the Defense Mapping Agency (DMA), later reorganized into NIMA, created the Geospatial Information Integrated Product Team (GI IPT) for an interagency examination of the issues brought forward by the Army and Defense Science Boards. The IPT addressed resource limitations, production process limitations, inherent data problems, the dynamic threat environment, and the "smart" information requirement of warfighter systems.[26] The results for the GI IPT were published in October 1997 in a three volume document called the "Geospatial Information Infrastructure Master Plan" (GII MP).[27]

The GII MP clarified the Foundation Data (FD) Concept and described the changes NIMA and the customers of mapping products needed to make in order to achieve the Information Superiority tenet of the Joint Vision. Instead of providing a suite of standard products, the Foundation Data Concept is a production and archiving scheme that provides warfighters what they need, when they need it.[28] The concept creates a geospatial information framework of sufficient data content and accuracy to support global preparedness, theater readiness, and mission responsiveness through a three-prong approach to provide geospatial information:

Foundation Data (FD) supports initial operations and mission planning, provides near-global coverage, establishes known accuracy and quality, accommodates rapid update cycles, and facilitates automated decision making. Foundation Data consists of Controlled Imagery Base (CIB) imagery with 5 meter resolution, Digital Terrain Elevation Data (DTED) Level 2, Foundation Feature Data which consists of feature and attribute information, and classified one meter stereo imagery called Digital Point Positioning Data Base (DPPDB) that supports precision targeting, detailed feature identification, and extraction.

Mission Specific Data Sets (MSDS) encompass densification of Foundation Data. MSDS are defined by warfighters to support their mission and area requirements. MSDS are defined by elevation, imagery, or feature and attribute requirements and conform to established DOD data specifications.

Qualified Data is alternate sources of geospatial information, including legacy standard products, which are not produced to the positional accuracy of FD and MSDS.

ARMY EFFORTS TO DEFINE MSDS

The U.S. Army Topographic Engineering Center (TEC) and the Training and Doctrine Command (TRADOC) Program Integration Office for Terrain Data (TPIO-TD) had been collecting and validating Army user and system requirements for geospatial information since the late 1980's. However, in order to implement the Foundation Data Concept, the Army had to

specify the types of imagery, elevation, and feature/attribute data needed to fulfill specific missions.

Describing MSDS requirements for imagery or elevation data was relatively simple since warfighters simply choose an area and needed imagery or elevation resolution.

Defining MSDS needs for feature/attribute information was much more complicated. The Army's initial efforts to define MSDS centered on force size, force type, and mission. For example, the Army tried to ascertain if geospatial requirements could be determined for an armor brigade attacking an enemy force. After a year of dedicated effort, it became obvious there were geospatial requirements that could not be defined by force type, size, or mission. For every operation, there is a unique set of requirements based on mission, enemy, terrain and weather, troops, time available, and civilian considerations (METT-TC). A variation in any one of the components of METT-TC can have a significant effect on the commander's concept of operation, and thus, geospatial information requirements.

Since clearly defined packages of MSDS could not be defined, the Army developed packages of geospatial information that incorporated the map display characteristics of 1:50,000 and 1:100,000 scale topographic maps, as well as the features and attributes required to conduct analysis. At the Army's request, NIMA made prototypes of the Army's five levels of MSDS. Over one hundred and thirty Army commands, agencies, and activities participated in the evaluation of the Army MSDS prototypes. Based on the responses from the field, the Army refined its geospatial requirements in June 2000 in a memorandum to NIMA.[29]

However, geospatial information encompasses more than terrain data. Information about the military and political situation is large and increasing daily. Today, electronic data mining is one of the most productive ways to locate data that exists in cyberspace.[30] For information to be useful, it must be organized so that it can be quickly located and retrieved. Since geospatial and informational databases will be distributed, they must accommodate robust cross-database queries and retrieval methods.

The Defense Science Board 2000 report on the National Imagery and Mapping Agency identified three principles to enable geospatial and other information sources to easily contribute to information superiority:[31]

- Stand-alone mapping and imagery products need to be replaced by geospatially referenced imagery and mapping data that are fused into a common framework.
- Geospatially referenced products from other intelligence sources, such as SIGINT and MASINT, can then be fused into the common geospatial framework. The result is an enhanced common operating picture.

- U.S. must define a flexible and robust process for the tasking, processing, exploitation, and dissemination (TPED) of imagery and geospatial information. TPED should be based upon an internet-based architecture from which the consumer can pull data and through fusion and geo-registration, create customized intelligence products.

TRANSFORMING GEOSPATIAL INFORMATION TO RELEVANT KNOWLEDGE AND DECISION SUPERIORITY

> The magnitude of available information challenges leaders at all levels. Ultimately, they must assimilate thousands of bits of information to visualize the battlefield, assess the situation, and direct the military action required to achieve victory.
>
> —FM 100-5

As illustrated in Figure 6, information is data that has been processed and placed in a situational context to gain meaning. Knowledge is information that has been tested and accepted as fact. Understanding is obtained by applying judgment to knowledge. Commanders make decisions based on their experience, training, knowledge, and understanding of a situation.[32] Ambiguity should be reduced with each step up the cognitive hierarchy.

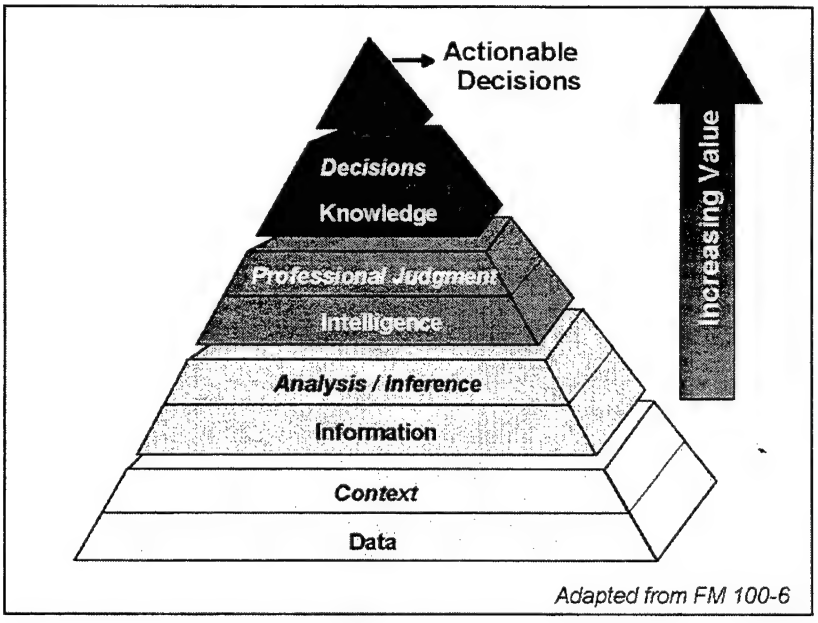

FIGURE 6. COGNITIVE HIERARCHY

Decision superiority does not automatically result from information superiority. Having better information does not necessarily lead to information superiority. It is only when the information is effectively translated into superior knowledge, can superior decisions be made and implemented faster than an adversary can react. With decision superiority the Army can shape the environment and quickly react to changes.[33]

In order to make superior decisions, commanders must be supplied with relevant information. Relevant information is defined as information drawn from the environment that significantly impacts, contributes to, or is related to the execution of the operational mission at hand. Relevant information supports the creation of situational awareness which directly contributes to effective Command and Control (C2), during all stages of the decision and execution cycle, to aid the commander in ensuring unity of effort toward mission accomplishment.[34]

It is difficult to know what information is relevant. Types of information deemed as relevant in one operation may not be relevant in another. Therefore, many geospatial analysts attempt to provide as much information as possible, forcing commanders to determine what is relevant and what is not.

Information continues to deluge U.S. forces. Success in future crisis operations depends on the accuracy and speed of relevant information and the speed and mobility of the deploying units. Army transformation has set its objectives for rapid deployment. Transformation includes the Future Combat System (see Figure 4) which will use a "system of systems" approach to connect sensors to Reconnaissance, Surveillance, & Target Acquisition (RSTA) systems so that information collectors and users of information are linked. However, it takes more than linking systems to obtain the quality, timely, and relevant information necessary to obtain decision superiority.

Crisis support requires that strategic assets and agencies are front-loaded with updated databases so that relevant information and answers to commander's questions can be provided before questions are asked.[35] Providing relevant geospatial information requires that the Army has the ability to rapidly tap all information archives and task national, tactical, and commercial sensors to gain near-real time information in order to provide a accurate understanding of the battlespace and the adversary.[36] The battlespace is never static, so geospatial information analysts must continually update the operational and tactical situation, emerging targets, and perform battle damage assessments.[37]

Supplying knowledge to commanders is measured in timeliness (including velocity of delivery), accuracy, precision, customization to the decision at hand (elimination of the extraneous) and insight provided by the information.[38]

Often, information can be imperfect or distorted. Providers exploiting data, as well as commanders using the information must assess the quality of the information prior to its use. In order of priority, the six criteria to consider before using the information are:[39]

Accuracy. Information must convey the actual situation. This element requires superior analytical skills. The geospatial community is plagued with the loss of expert analysts. Since geospatial analysis is a blend of art and science, experience is essential. To the fullest extent possible, a variety of source data should be used. For example, imagery intelligence (IMINT) should be integrated with human intelligence (HUMINT) and signal intelligence (SIGNIT).

Relevance. In order to support specific missions, the geospatial community must provide only the information that applies to the particular mission, task, or situation. This requires geospatial analysts to understand the military decision making process (MDMP) and how the geospatial information applies to each situation or operational level.

Timeliness. Geospatial information must be available in time to make decisions. If information is provided too late, it can be insignificant. Information must also be delivered to the right user. During times of crises, high velocity delivery of the needed information is critical.

Usability. Geospatial information must be provided in easily understood formats and displays. For example, a three-dimensional image can aid in the understanding of choke points, cover/concealment, and elevation. Provided information must also be usable in the appropriate systems. Information standards assure that data is usable in all systems.

Completeness. In order to provide complete information, geospatial information must be integrated with all information that is required by the decision-maker. The integration or fusion of all relevant information enables superior knowledge. As illustrated in Figure 7, the fusion of elevation data with transportation, drainage, and vegetation provides a better understanding of the terrain than the same information without elevation.

Precision. Superior knowledge requires that the information provided is at the right level of detail for its intended use. Relevant information at the tactical level is usually too detailed for strategic analysis. Conversely, the geospatial information needed at the strategic level may have little use at the tactical level.

Ultimately, decision superiority depends on the right person having the right information at the right time. Incomplete or imprecise information is better than none at all; late or unusable information is the same as none at all; inaccurate or irrelevant information is worse than none at all.[40]

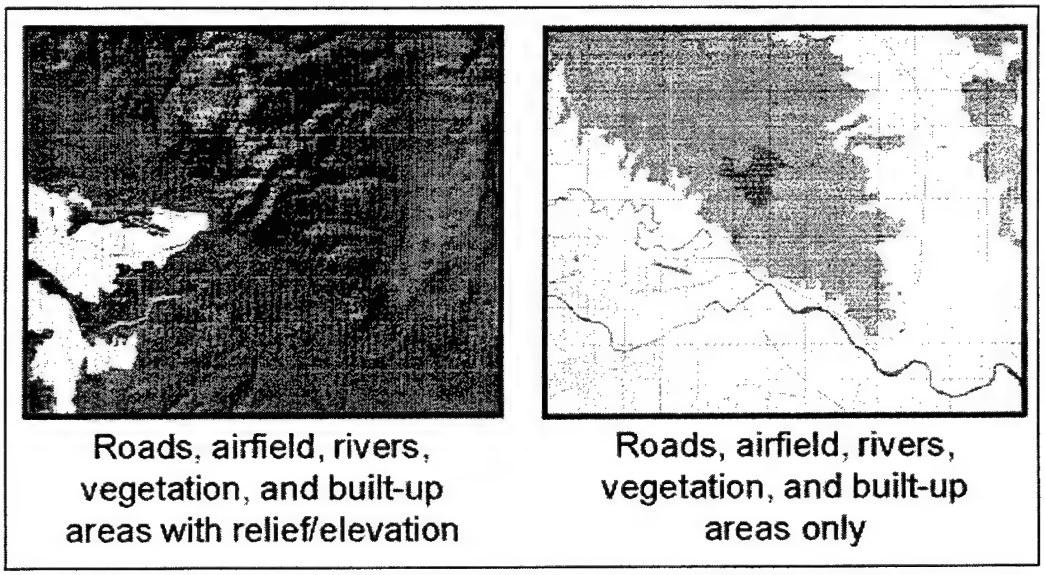

FIGURE 7. COMPARISON OF FUSED INFORMATION AND MAP DATA

Information capabilities are advancing so quickly that the Army's ability to comprehend data, devise plans, and assess consequences can be overwhelmed. Massive amounts of data must be analyzed and translated into understanding. This never-ending cycle of collection, analysis, and understanding makes decision-making dynamic and multidimensional. The expanding use of data makes Information Management a vital element of Decision Superiority.

Information Management is essential to strengthen the commander's awareness of widely dispersed forces and non-contiguous areas of operations. Knowing where the information is located and rapidly accessing it can be as important as the analysis and fusion of information.

Commanders must evaluate the geospatial information and intelligence in the cultural, political, military, and economic characteristics of the area of operations. Harnessing and providing the best information is only as good as the commander's judgment, wisdom, experience, and intuition to understand and use the information/knowledge provided.

RECOMMENDED NEXT STEPS

Despite recent attention by the Defense Science Board, Army Science Board, Joint Publication 2-03 (Joint Tactics, Techniques, and Procedures for Geospatial Information and Services Support to Joint Operations) and the Army's draft Concept for Army Imagery and Geospatial Information and Services (AIGIS), the DOD community and Army have not gone far enough to transition from supplying information to supplying knowledge and understanding. Current efforts are aimed at meeting today's geospatial requirements, not the geospatial requirements of the Objective Force.

Building a knowledge advantage requires a highly developed sense of what information is required and an ability to manage and disseminate that knowledge to the right place, at the right time, for the desired purpose. However, designing the information and knowledge requirements for the Objective Force must take into account the human dimension of understanding. Having grown up with computers and instantaneous information, today's eight-year-olds (the future Objective Force) will use information differently than it is used today.

Research and development in today's geospatial environment is mostly done by scientists and engineers in their 30s, 40s, and 50s. Currently, researchers are searching for increasing amounts of enhanced information instead of taking a minimalist approach of only requesting the simplest information needed to understand a situation. Part of this dilemma is that analysts and commanders want to avoid ambiguity, especially when it occurs in a widely dispersed battlespace. A second part of the dilemma is that the information needed is based on Mission, Enemy, Tactics, Terrain, Time, and Civilian Considerations (METT-TC) aspects of each operation. The METT-TC considerations for one section of the battlespace can be vastly different from another section of the battlespace.

Types of information deemed as relevant in one operation may not be relevant in another. Even with a perfect understanding of what geospatial information is required and a robust system to deliver the information to those requiring it, the Army is missing the human element of providing knowledge, not information.

The Army must begin now to meet the geospatial information requirements of the Objective Force. The following technological studies, education, and cooperation programs are recommended to assist in advancing geospatial information to relevant knowledge:

TECHNOLOGY

The Army must experiment with the fusion of differing types of information to determine the best methods to create a rapid understanding of geospatial information. The Army must

ensure that geospatial algorithms, such as helicopter drop zones and cross country movement, use the minimal amount of geospatial information required for accurate predictions. In addition, it must determine if geospatial algorithms accurately capture the information required by military decision-makers. The challenge is to find better, not just faster, analysis and decision-making procedures.

MILITARY

Today, topographic engineers are the major users of most geospatial information. However, in the future all military personnel will use geospatial information to some extent. Therefore, all military personnel must be trained to understand and use geospatial information so they can precisely request the types of information they require. Staff organizations and procedures must adjust to the richer flow, faster pace, and huge volume of information.

CIVILIAN

Most geospatial information analysis is performed by civilians, with little to no military experience. Civilians must gain an understanding of operations in order to effectively deliver what their military counterparts need. Geospatial organizations must train their employees in military doctrine, tactics, and techniques.

CIVILIAN-MILITARY COOPERATION

When possible, civilians should participate in military exercises at the tactical, operational, and strategic levels. Opportunities must be developed for civilian producers of geospatial information to interact with military personnel. The time to develop military-civilian work relationships is before crises occur. With experience, civilian analysts will be able to anticipate the types and resolution of geospatial information required before it is requested by the military.

GEOSPATIAL INVESTMENTS FOR THE OBJECTIVE FORCE OF 2020

The Army must make investments in civilian and military education, technological advancements, scientific understanding, and civilian-military cooperation today for the Objective Force to be successful across the entire spectrum of operations in 2020.

Word Count = 5677

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